

# Assessment of Accelerated Tests Compared to Beachfront Test and Proposed Evaluation Method

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# Outline

- **Background and Test Parameters**
- **Results of Comparison of Accelerated and Beachfront Tests**
- **New NC Systems Testing: Panels and Galvanic Assemblies**
- **Conclusions and Plans**



# **Background**

- **Environmental Security Technology Certification Program (ESTCP) funded project entitled “Non-Chromate Aluminum Pretreatments” (NCAP)**
  - Funding began in 2000, ended 2004 for Phase I assessment
  - Panels prepared 2000/2001
  - Accelerated tests completed in 2001
  - Beachfront test began in November 2001 and is continuing
- **Original Intent: compare the performance of 8 candidate non-chromate aluminum conversion coatings compared to chromated control using a variety of DoD aluminum substrates, paint systems, and standard tests**
  - Joint Test Protocol: defines all tests and materials
  - Phase I and Interim Reports document all test data as of 2004
  - Beachfront data continues to be collected for surviving coatings
- **Current Intent: Compare performance of all coatings in accelerated corrosion tests to beachfront test**

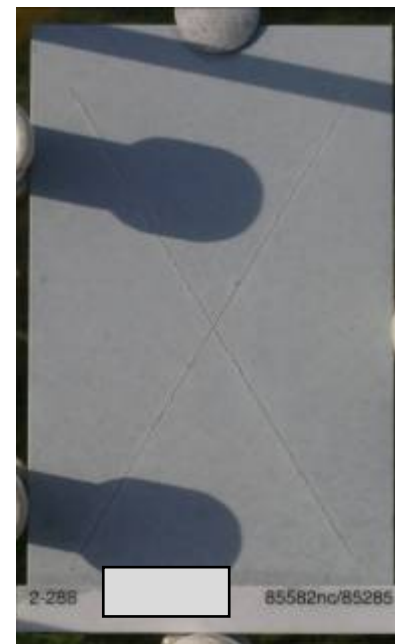
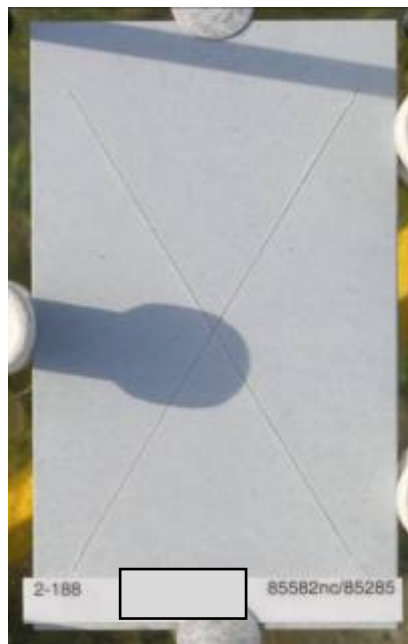
# NCAP Data Assessment

## **Data set includes:**

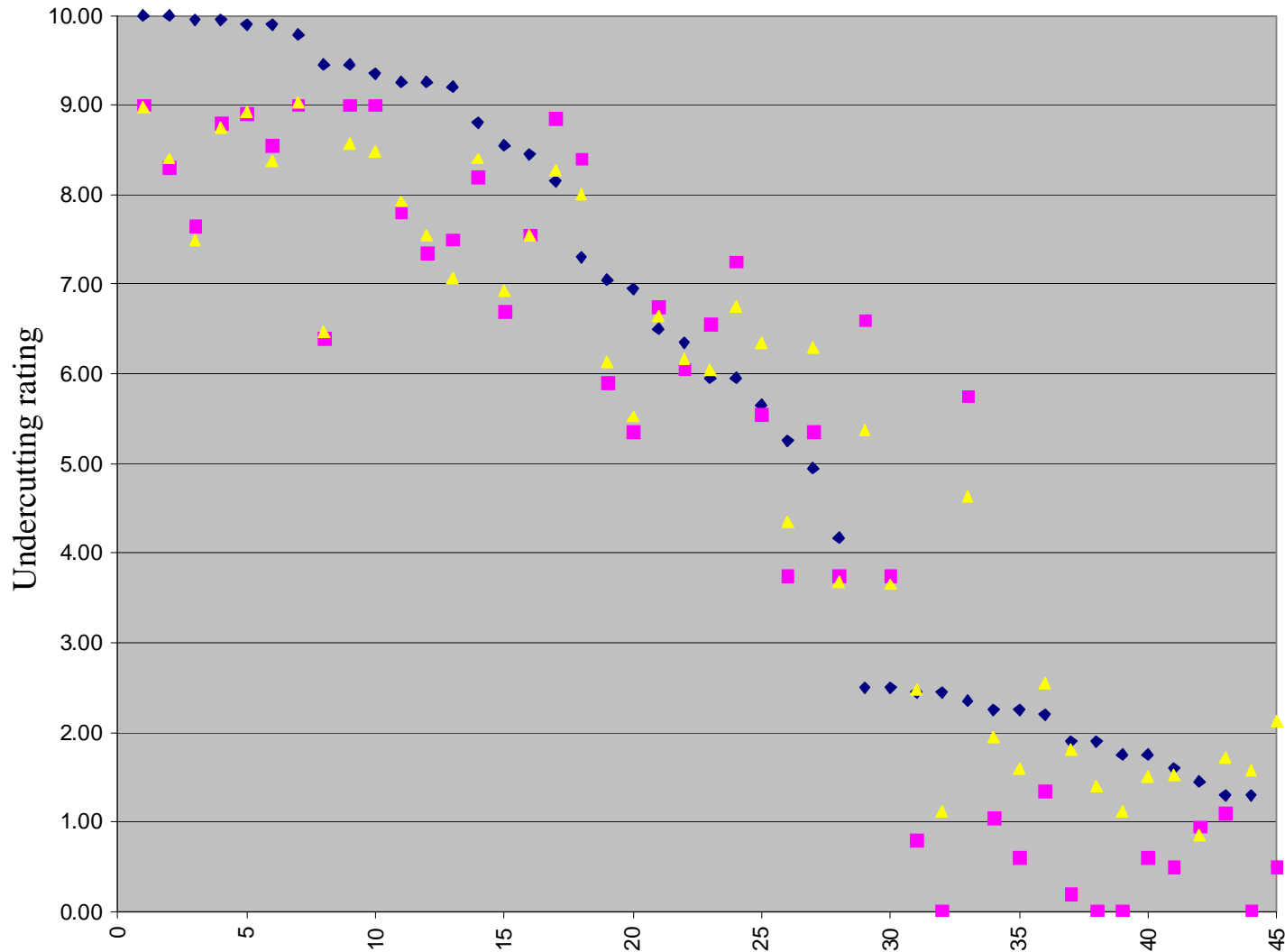
- 4 aluminum alloys: 2024, 7075, 2219, 5083
- 9 conversion coatings/pretreatments (including one chromate control)
- 5 paint systems
  - MIL-PRF-23377 Class C primer w/MIL-PRF-85285 topcoat (chromate, high-solids)
  - MIL-PRF-85582 Class C primer w/MIL-PRF-85285 topcoat (chromate, water)
  - MIL-PRF-85582 Class N primer w/MIL-PRF-85285 topcoat (non-chromate, water)
  - MIL-C-53022 primer w/MIL-C-53039 topcoat (non-chromate, high-solids)
  - MIL-C-53030 primer w/MIL-C-53039 topcoat (non-chromate, water)
- 4 corrosion tests (with 5 replicates per coating system)
  - ASTM B 117 for 3000 hours (completed by ARL)
  - GM9540P for 120 cycles (completed by ARL)
  - ASTM G85 Annex 4 (SO<sub>2</sub>) for 500 hours (completed by NAVAIR-PR)
  - Beach front at Kennedy Space Center for 5 years (completed by NASA)

# **Analysis of Data**

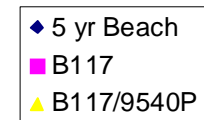
- **Excel software used to analyze and plot data**
- **Initial focus on comparing end points of tests**
- **A variety of combinations of variables was studied**
  - All alloys and coatings
  - All alloys for each primer
  - 7075 and 2024 for all coatings
  - 2024 for all coatings
  - Beach vs ASTM B117, ASTM G85 Annex 4 (SO<sub>2</sub>), GM9540P, B117/SO<sub>2</sub>, B117/9540P,



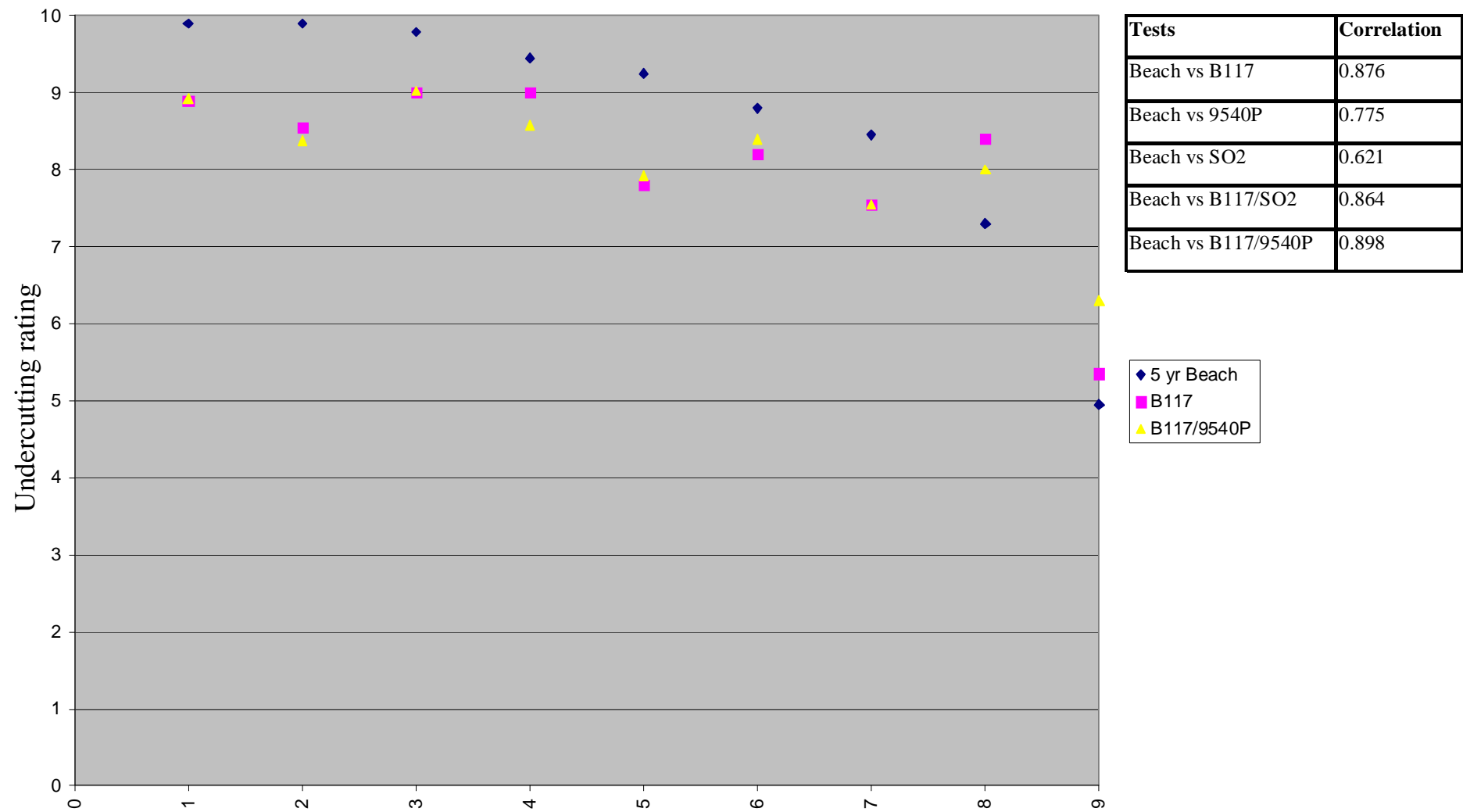
# All Alloys and Coatings



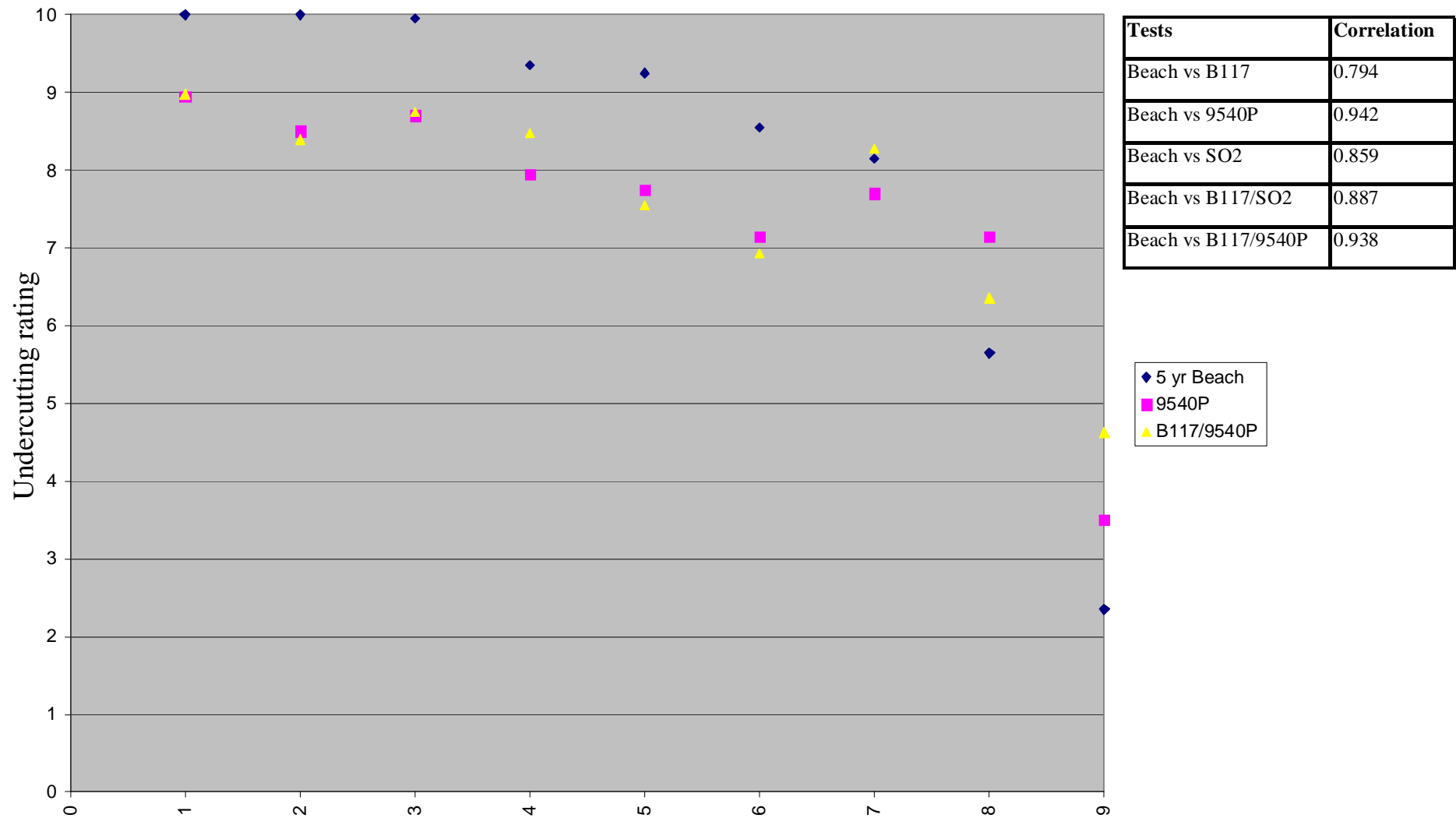
Tests	Correlation
Beach vs B117	0.915
Beach vs 9540P	0.94
Beach vs SO2	0.825
Beach vs B117/SO2	0.908
Beach vs B117/9540P	0.943



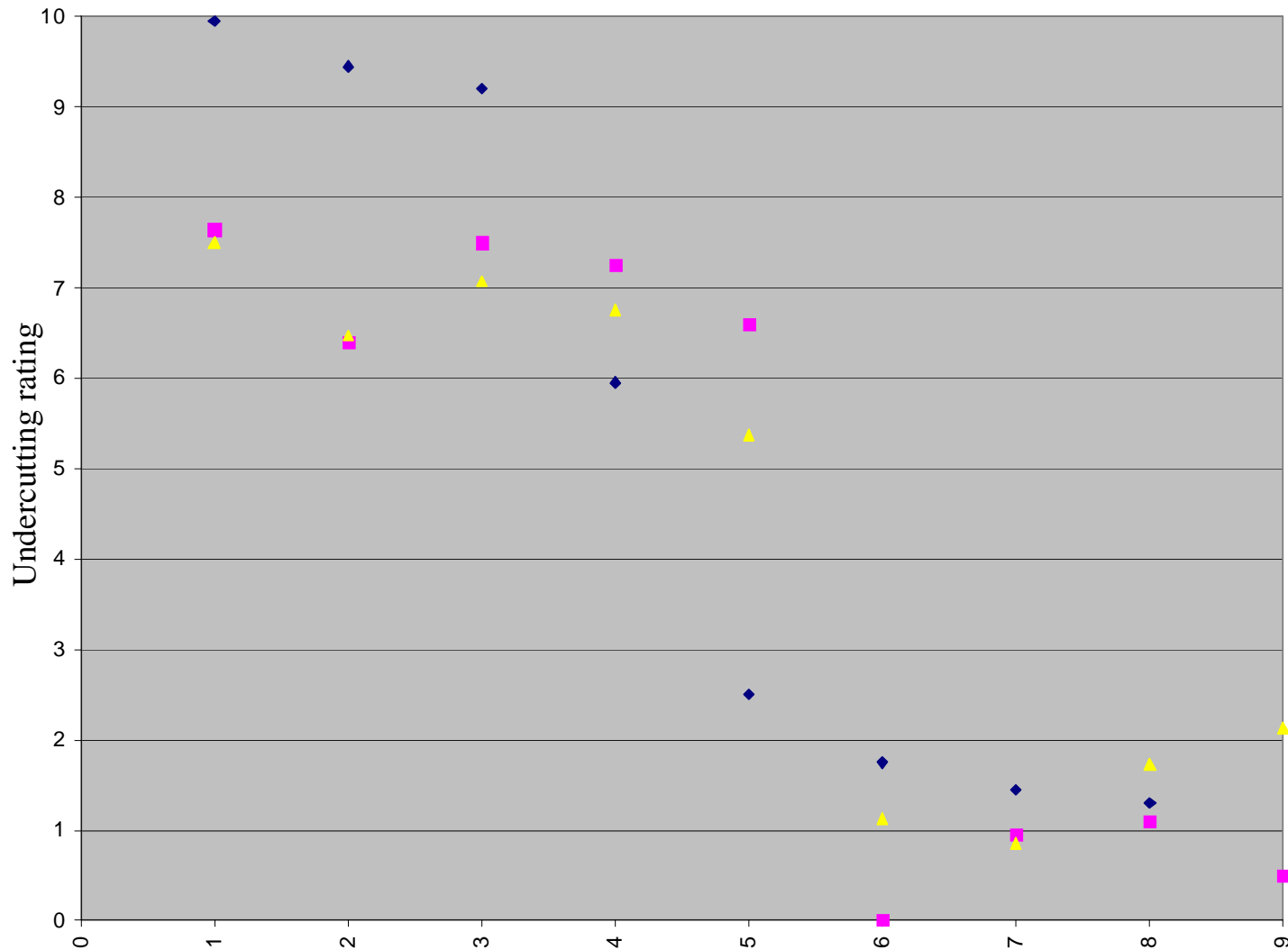
# All Alloys with MIL-PRF-23377 C2



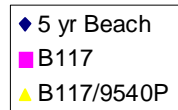
# All Alloys with MIL-PRF-85582 C1



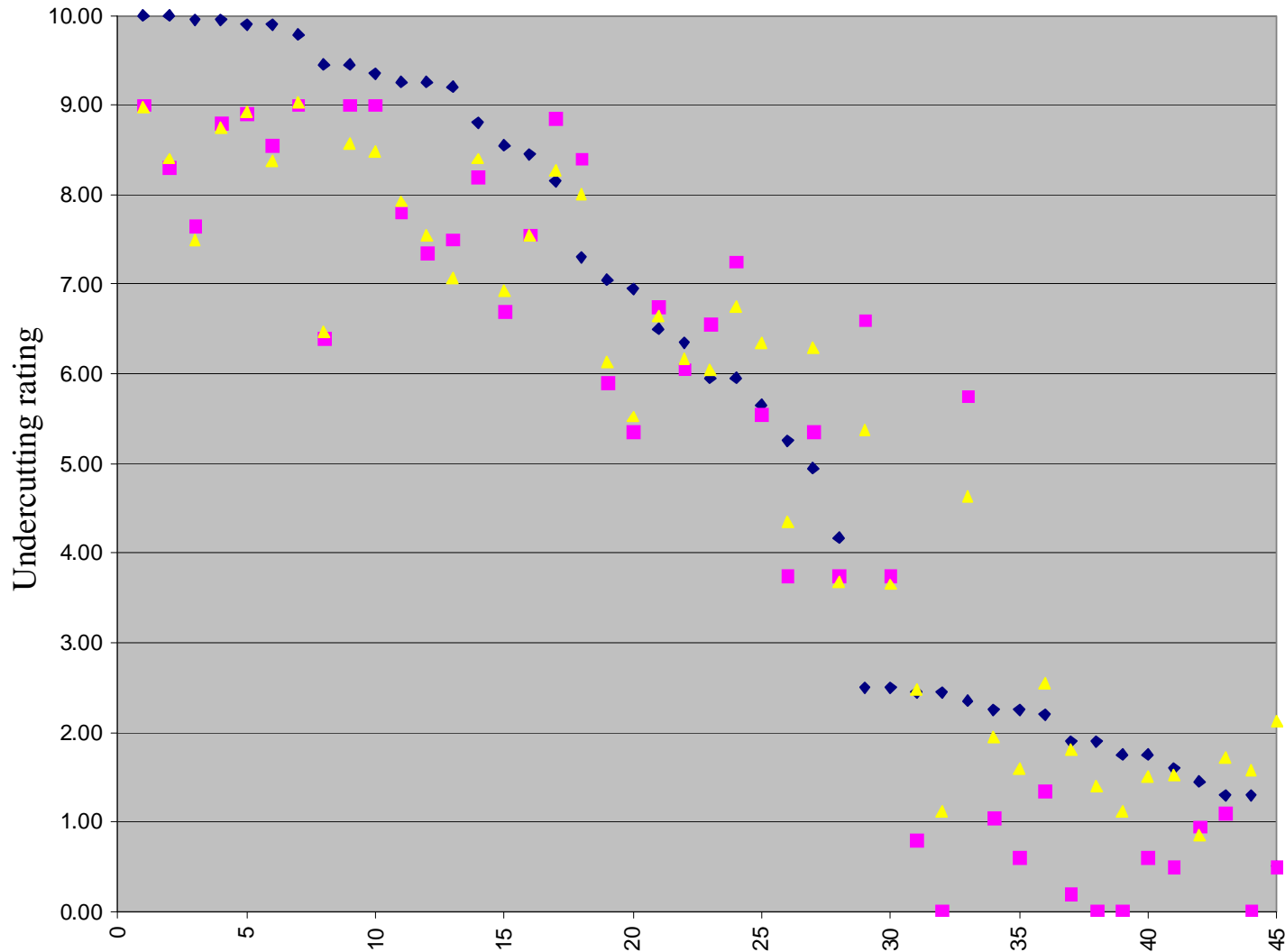
# All Alloys with MIL-PRF-85582 N



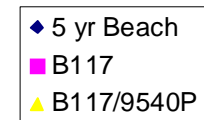
Tests	Correlation
Beach vs B117	0.838
Beach vs 9540P	0.893
Beach vs SO2	0.837
Beach vs B117/SO2	0.854
Beach vs B117/9540P	0.886



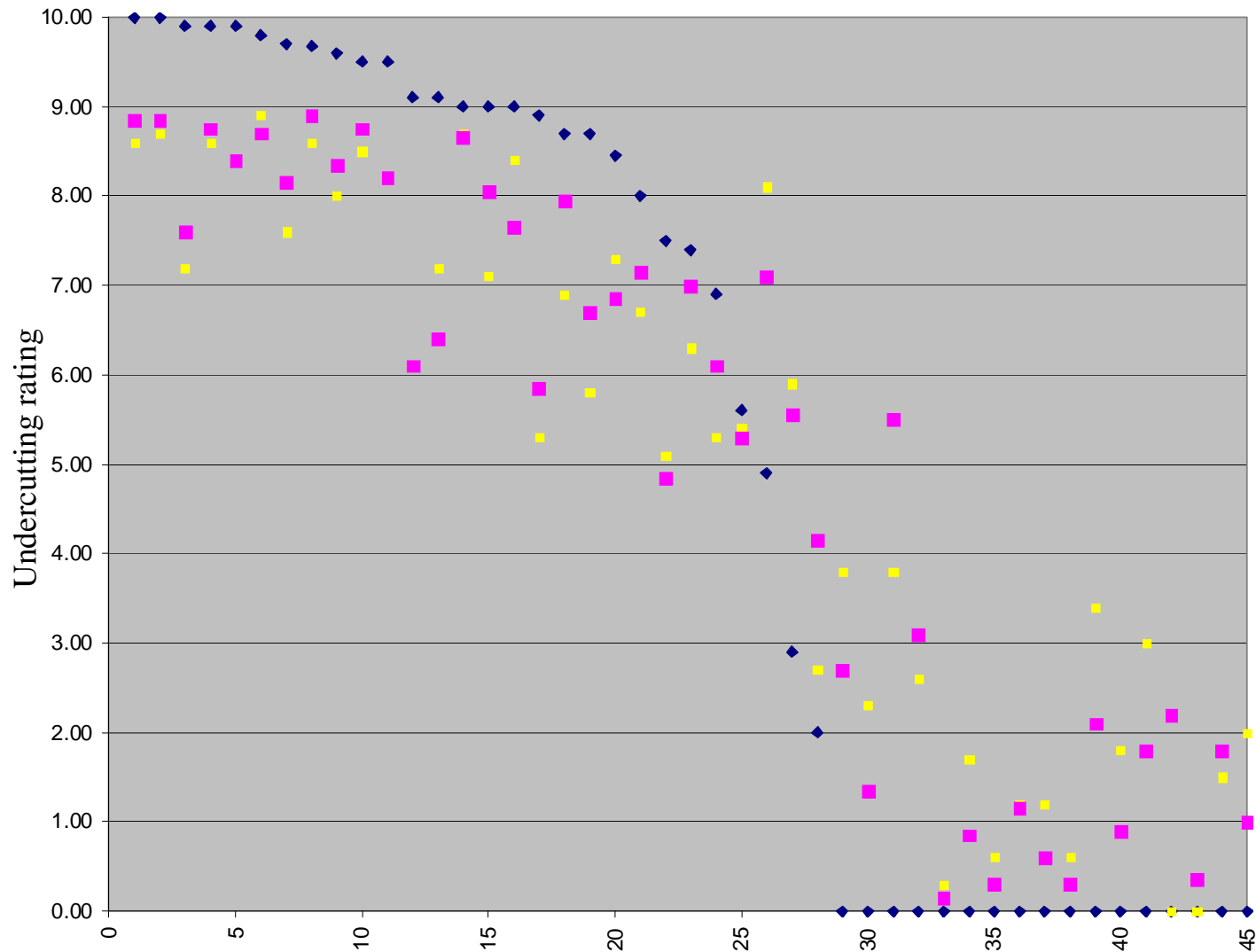
# All Alloys and Coatings



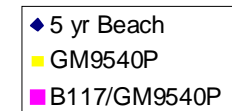
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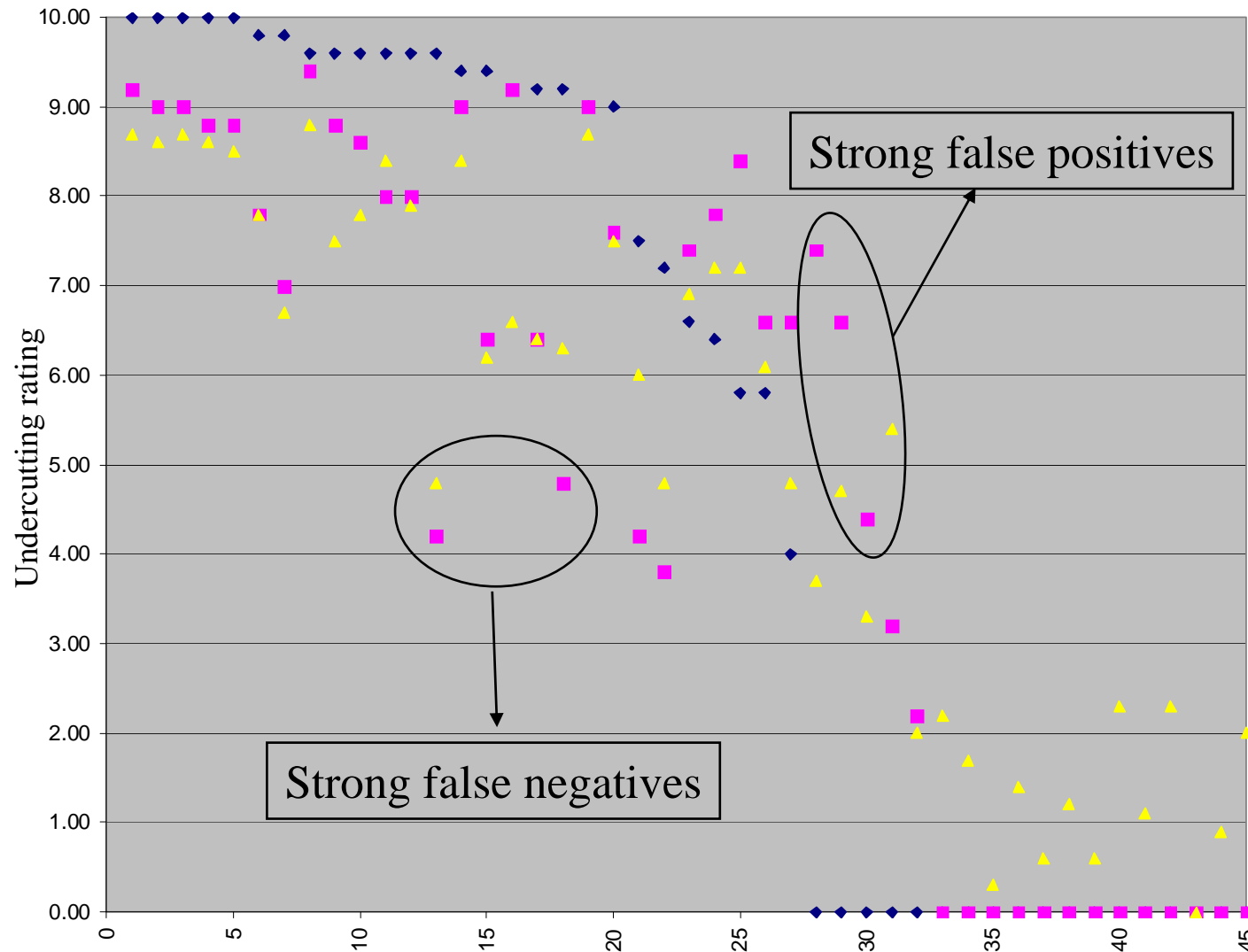
# 2024 and 7075 with All Coatings



Tests	Correlation
Beach vs B117	0.898
Beach vs 9540P	0.922
Beach vs SO2	0.762
Beach vs B117/SO2	0.885
Beach vs B117/9540P	0.934



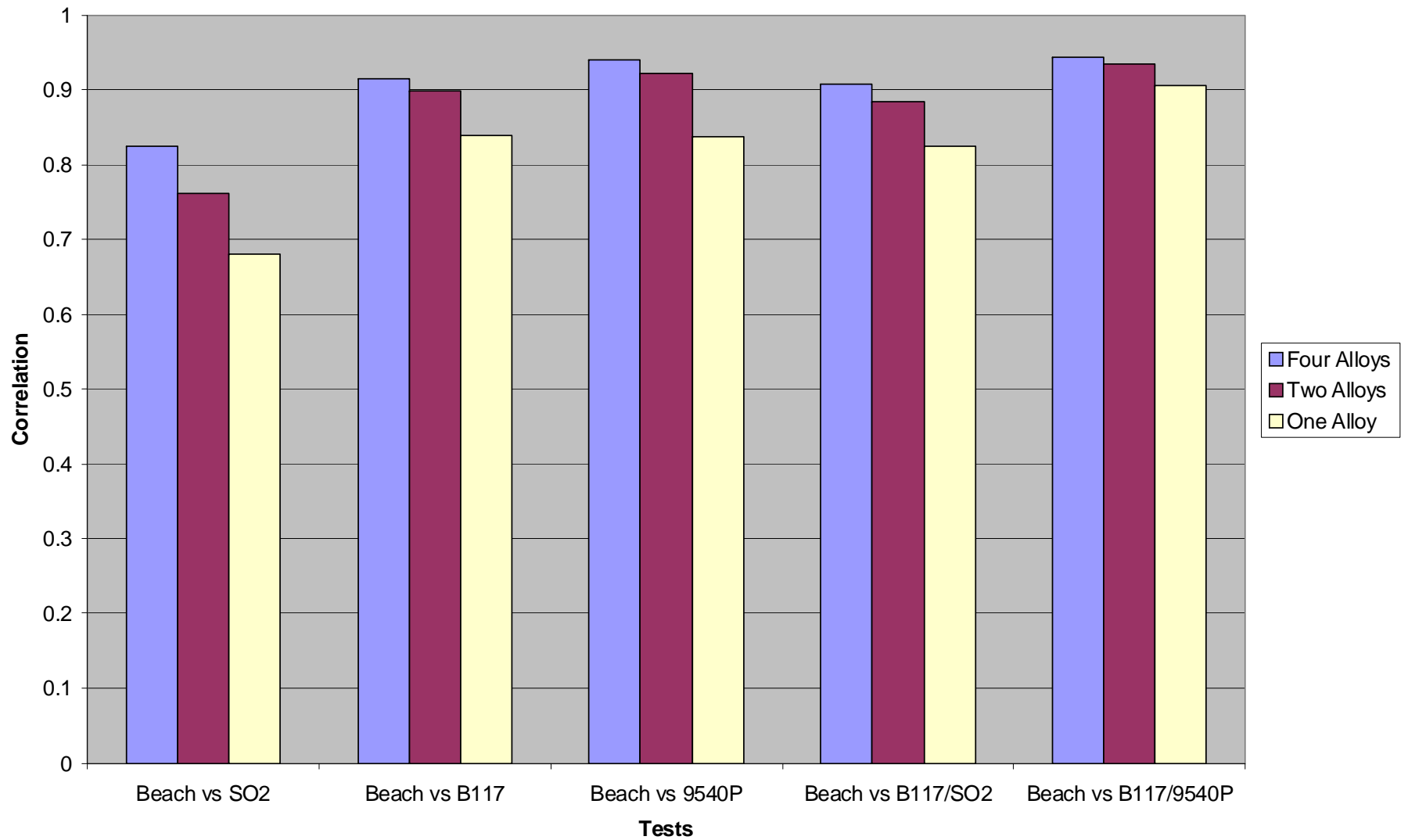
# 2024 with All Coatings



Tests	Correlation
Beach vs B117	0.839
Beach vs 9540P	0.837
Beach vs SO2	0.68
Beach vs B117/SO2	0.824
Beach vs B117/9540P	0.906

◆ 5 yr Beach
■ B117
▲ B117/GM9540P

**Effect of Number of Alloys on Data Correlation**

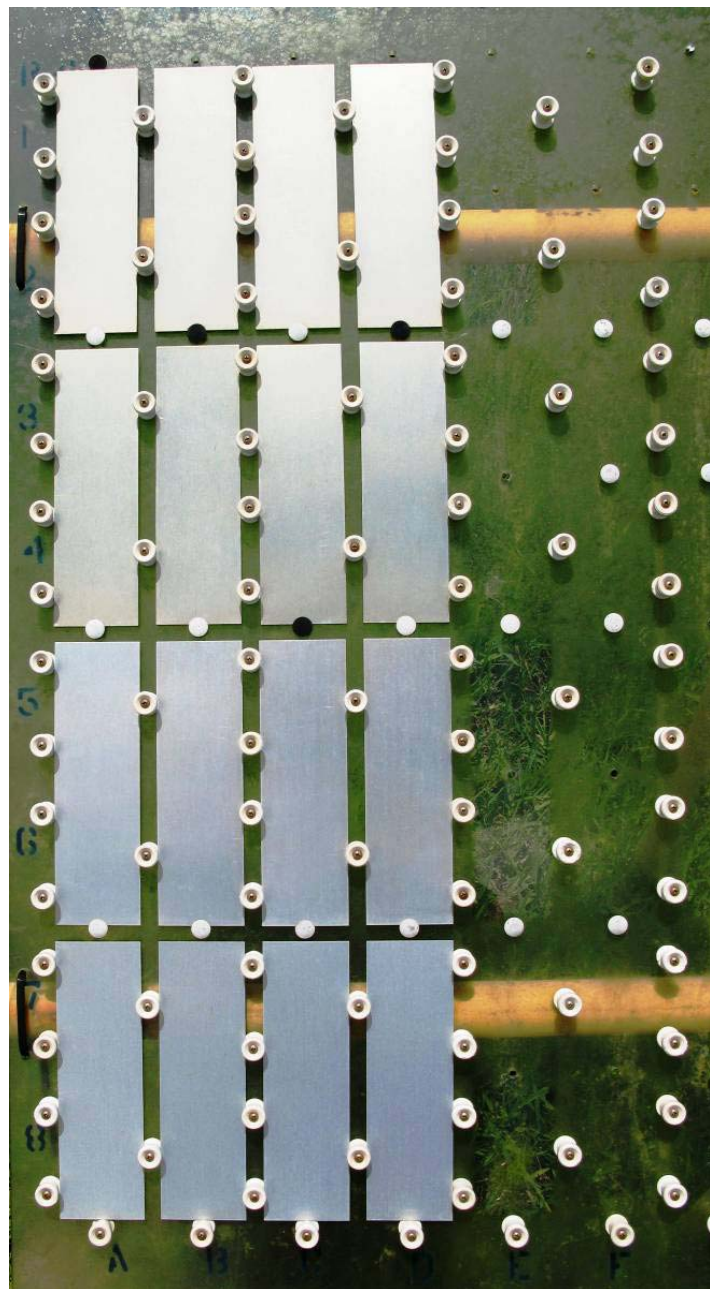


# Beachfront Exposure of Unpainted Conversion Coatings

- **2024-T3 and 7075-T6**
- **5 each alloy and coating**
- **Alodine 1600 (chromate control)**
- **TCP-IC (developmental)**
- **Started 11/07**



# 18 Months Exposure at KSC



## 20X view of surface

As is

Cleaned

**2024-T3  
Alodine 1600**

**2024-T3  
TCP-IC**

**7075-T6  
Alodine 1600**

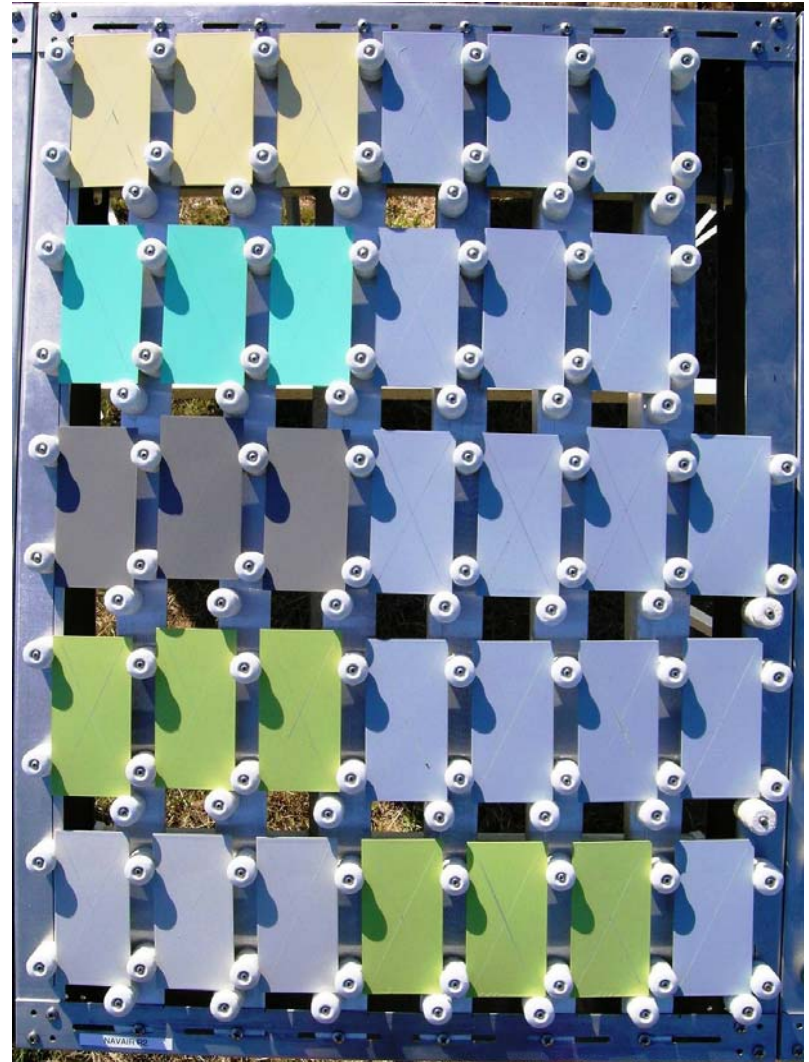
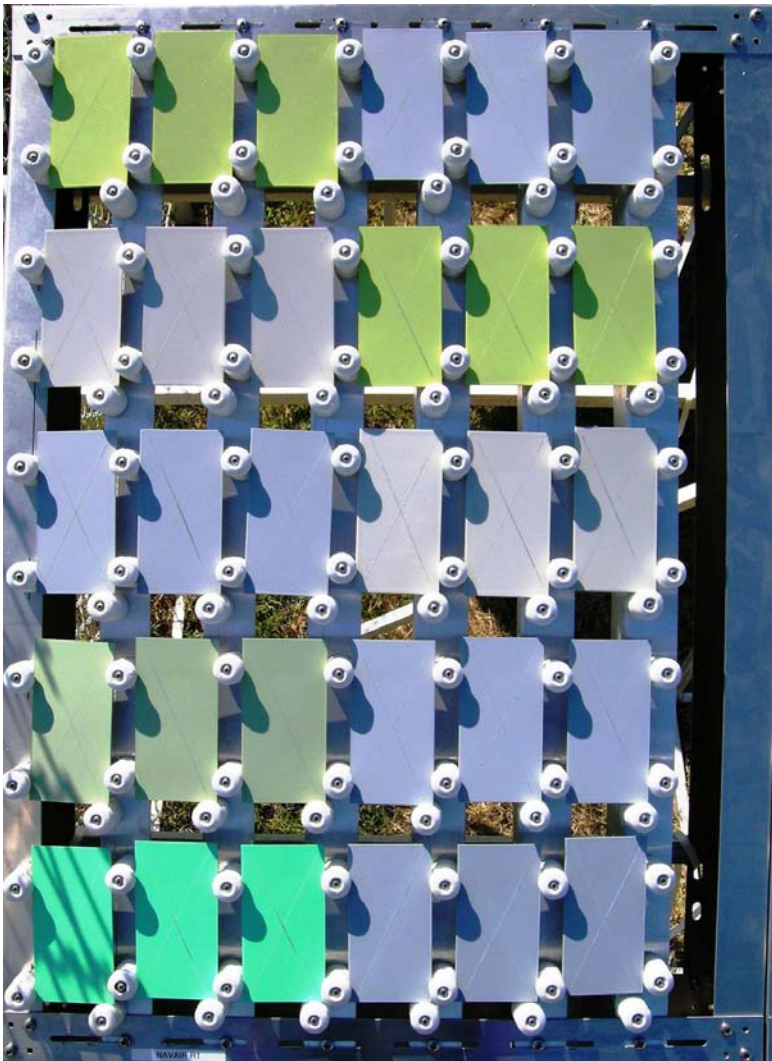
**7075-T6  
TCP-IC**

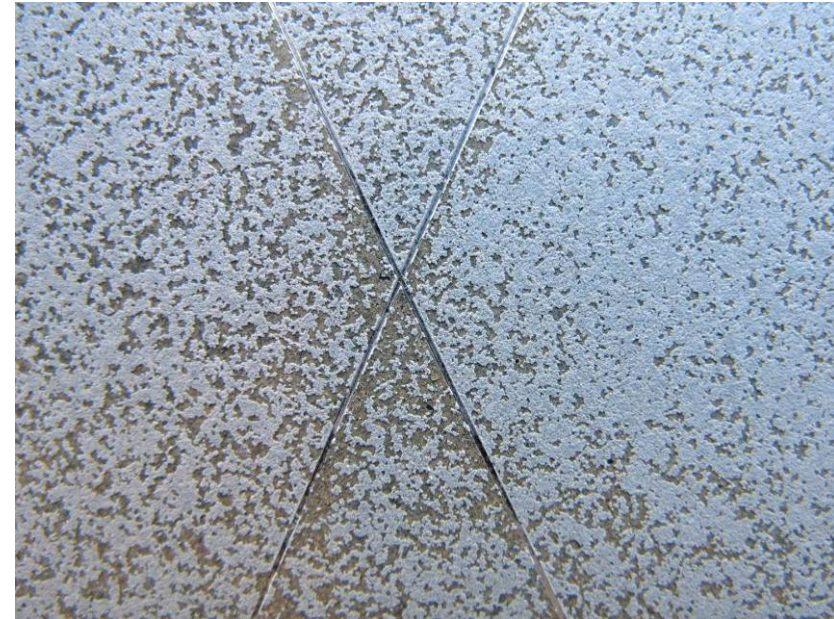
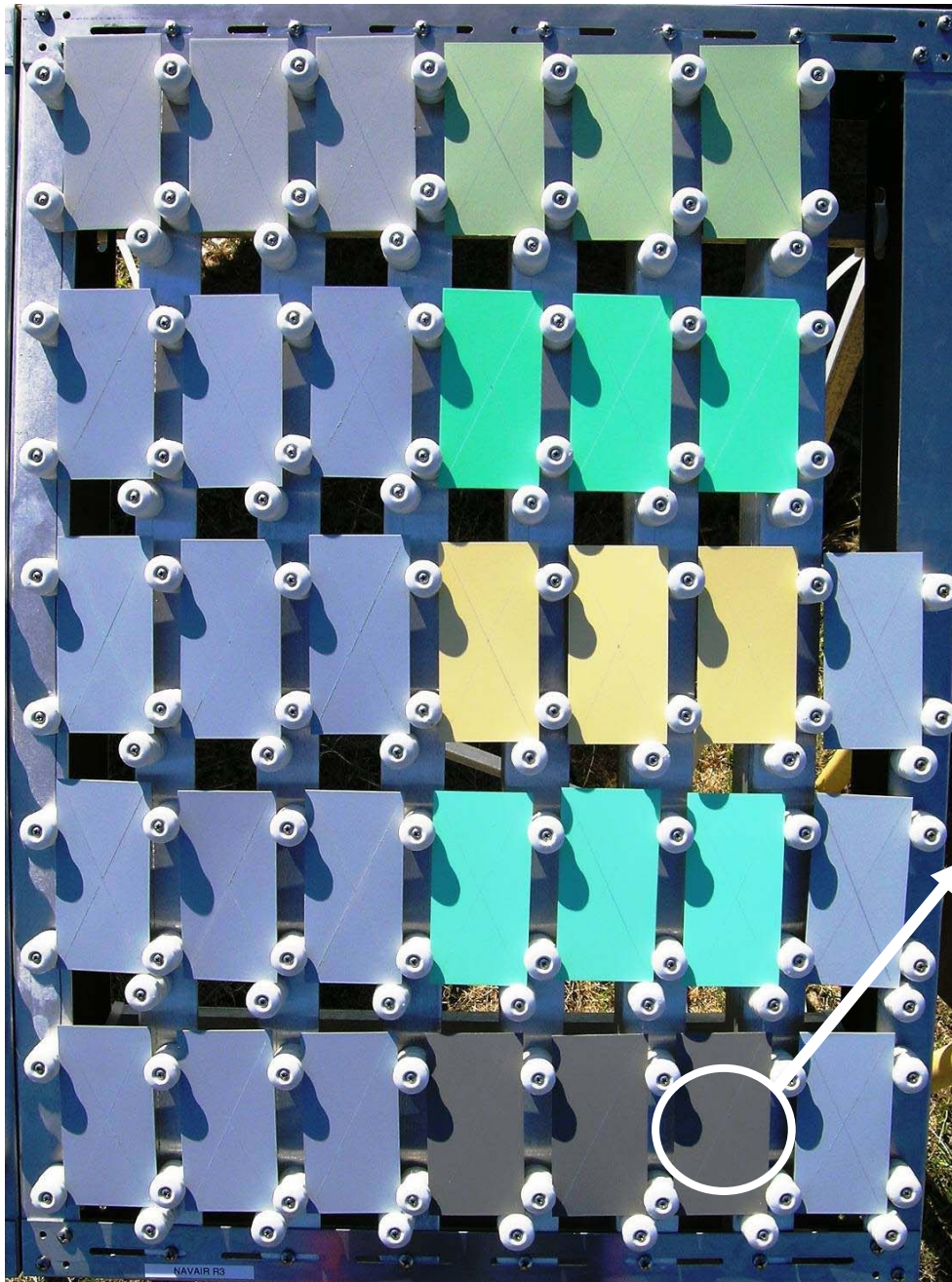
# Unpainted Corrosion Results for ASTM B117 and ASTM G85 A4

B117					G85					
Number	Rating 168 hr	696 hr	1344 hr	2500 hr	Number	Rating 24 hr	168 hr	504 hr		
7-3-412	10	10	8	4	7-3-417	6	5	5	Alodine 1600	2024
7-3-413	10	10	7	4	7-3-418	6	5	5		
7-3-414	10	8	9	4	7-3-419	6	5	4		
7-3-415	10	9	7	5	7-3-420	6	5	5		
7-3-416	10	8	4	5	7-3-421	6	5	5		
7-3-427	10	10	10	8	7-3-432	7	5	5	TCP-IC	2024
7-3-428	10	10	10	8	7-3-433	7	5	5		
7-3-429	10	10	10	8	7-3-434	7	5	5		
7-3-430	10	9	9	8	7-3-435	7	4	4		
7-3-431	10	10	10	8	7-3-436	7	4	4		
7-3-442	9	7	6	5	7-3-447	10	8	7	Alodine 1600	7075
7-3-443	9	7	6	5	7-3-448	10	8	7		
7-3-444	9	7	6	5	7-3-449	10	8	7		
7-3-445	9	7	6	5	7-3-450	10	8	7		
7-3-446	9	7	7	6	7-3-451	10	8	7		
7-3-457	10	8	8	7	7-3-462	7	6	5	TCP-IC	7075
7-3-458	10	9	8	7	7-3-463	7	6	6		
7-3-459	10	10	8	7	7-3-464	7	6	6		
7-3-460	10	10	8	7	7-3-465	8	6	6		
7-3-461	9	9	8	7	7-3-466	7	6	6		

# NC Coating Systems: Corrosion Assessment at KSC

## - panels as installed 11/07

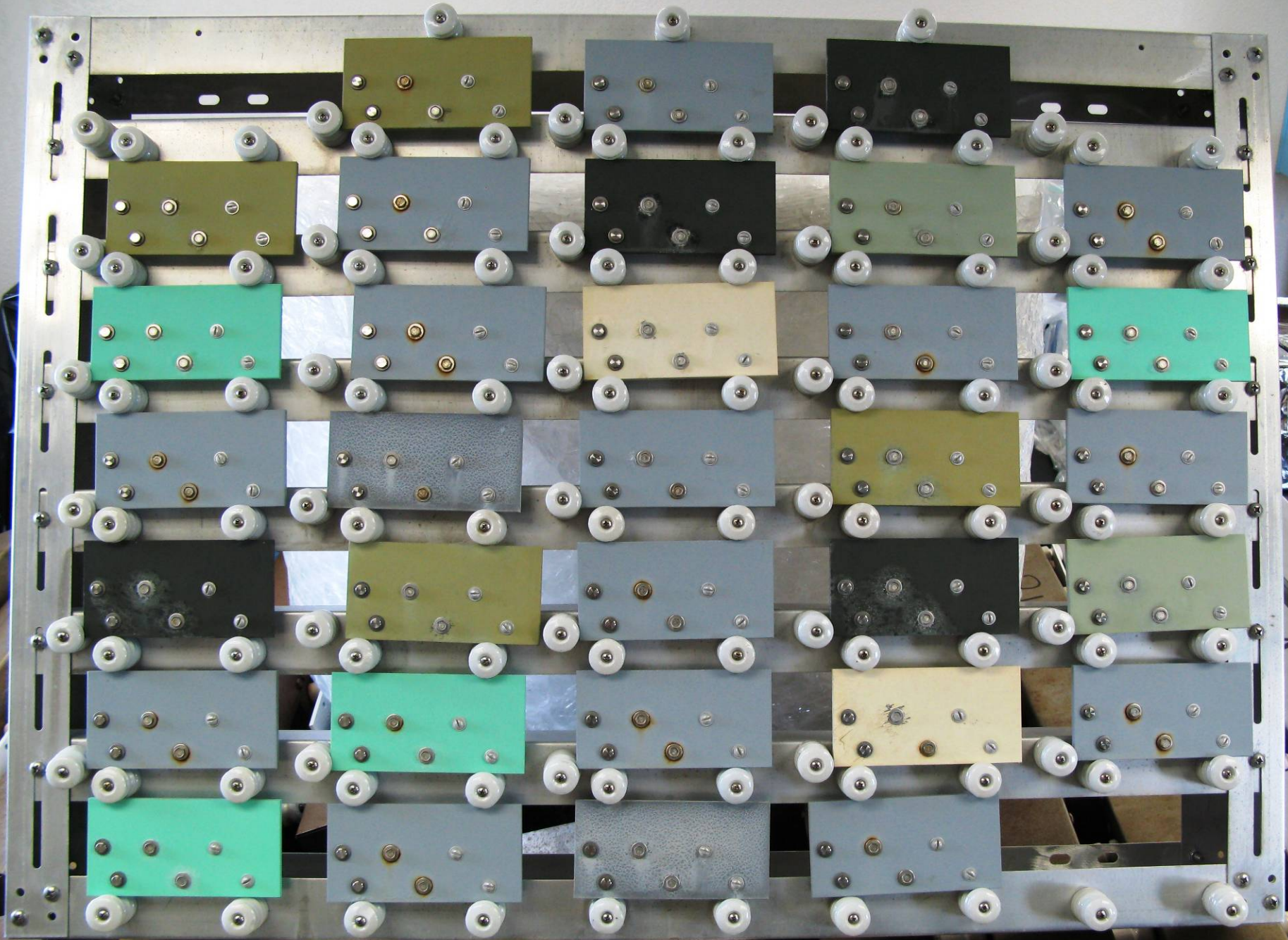




Surface after 15-month exposure  
(April 2009)



As installed- April 2008



After 5 months- September 2008

# **Conclusions and Plans**

- **The best correlations to beachfront with lowest risk of false positives and negatives were achieved by using multiple alloys and multiple tests- at least two for each.**
- **Maximum correlations to beachfront achieved using average of B117 and GM9540P data**
  - GM9540P and B117 showed similar correlations to beachfront
  - These tests show large drop in correlation when only one alloy was used
- **SO<sub>2</sub> correlation to beachfront clearly the worst**
  - Future work will attempt to gather on-ship data to investigate correlation with SO<sub>2</sub> and beachfront
- **Performance of Type I and Type II conversion coatings on beach very different than in salt fog- very little or no difference in performance between alloys and coatings at each rating interval up to 15 months**
- **Galvanic assemblies accelerate degradation of all coatings**
  - Method being pursued as rapid (3-6 month) validation of “plain” scribed panel performance which is expected to take 10+ years at KSC to yield failures of best coating systems